



Materials System Specification

01-SAMSS-017

13 October 2010

Auxiliary Piping for Mechanical Equipment

Document Responsibility: Piping Standards Committee

Saudi Aramco DeskTop Standards

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1 Scope

- 1.1 This specification defines the minimum mandatory requirements for the design, fabrication, installation and inspection of auxiliary piping associated with compressors, pumps, fans, turbines, engines and gears.
- 1.2 This specification is applicable for the services listed in Table-A-1 of Appendix-A. To use this specification for services other than those in the Table-A-1, prior approval from the Chairman of Piping Standards Committee shall be obtained in writing.

2 Conflicts and Deviations

- 2.1 Any conflicts between this specification and other applicable Saudi Aramco Materials System Specifications (SAMSSs), Engineering Standards (SAESs), Standard Drawings (SASDs), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Consulting Services Department of Saudi Aramco, Dhahran.
- 2.2 Direct all requests to deviate from this specification in writing to the Company or Buyer Representative, who shall follow internal company procedure [SAEP-302](#) and forward such requests to the Manager, Consulting Services Department of Saudi Aramco, Dhahran.

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

[SAEP-302](#)

*Instructions for Obtaining a Waiver of a
Mandatory Saudi Aramco Engineering
Requirement*

Saudi Aramco Engineering Standards

[SAES-H-001](#)

*Coating Selection and Application Requirements
for Industrial Plants and Equipment*

[SAES-H-101](#)

Approved Protective Coating Systems

Saudi Aramco Materials System Specification

[32-SAMSS-013](#) *Lubrication, Shaft Sealing and Control Oil
Systems for Special Purpose Applications*

Saudi Aramco Inspection Requirements

Form SA-[175-019800](#) *Auxiliary Piping*

Saudi Aramco Standard Drawing

[AB-036521](#) *Standard Drawing "Bridge Weld & Typical Brace
Seal Welded, and S.W. Valves on Process
Lines"*

3.2 Industry Codes and Standards

American Society of Mechanical Engineers

ASME B31.3 Process Piping
ASME B1.20.1 Pipe Threads, General Purpose (inch)
ASME B16.3 Malleable Iron Threaded Fittings
ASME B16.5 Pipe Flanges and Flanged Fittings
ASME B16.9 Wrought Butt Welding Fittings
*ASME B16.11 Forged Steel Fittings, Socket-Welding and
Threaded*
ASME B16.34 Steel Valves - Flanged, Threaded, and Welding End
ASME SEC IX Welding and Brazing Qualifications

American Society for Testing and Materials

*ASTM A53 Standard Specification for Pipe, Steel, Black and
Hot-dipped, Zinc-coated, Welded and Seamless*
*ASTM A105 Standard Specification for Carbon Steel Forgings
for Piping Applications*
*ASTM A106 Standard Specification for Seamless Carbon Steel
Pipe for High Temperature Service*
*ASTM A153 Standard Specification for Zinc Coating (Hot-Dip)
on Iron and Steel Hardware*
*ASTM A182 Standard Specification for Forged or Rolled
Alloy-Steel Pipe Flanges, Forged Fittings, and
Valves and Parts for High-Temperature Service*

<i>ASTM A197</i>	<i>Standard Specification for Cupola Malleable Iron</i>
<i>ASTM A216</i>	<i>Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service</i>
<i>ASTM A269</i>	<i>Standard Specification for Seamless and Welded Austenitic Stainless Steel Tube</i>
<i>ASTM A276</i>	<i>Standard Specification for Stainless Steel Bars and Shapes</i>
<i>ASTM A312</i>	<i>Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes</i>
<i>ASTM A403</i>	<i>Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings</i>

American Petroleum Institute

<i>API STD 602</i>	<i>Compact Steel Gate Valves - Flanged, Threaded, Welding, and Extended - Body Ends</i>
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National Association of Corrosion Engineers / International Standardization Organization

<u><i>NACE MR0175/ISO 15156</i></u>	<i>Petroleum and Natural Gas Industries - Materials for use in H₂S-Containing Environments in Oil and Gas Production</i>
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4 Definition

Auxiliary Piping: It is the piping connected to an equipment to support its function but is not part of the main process lines, i.e., suction and discharge.

5 Responsibilities

Vendor Responsibilities:

- 5.1 The Vendor of the mechanical equipment shall be responsible for the design of all auxiliary piping, within the scope of the purchasing contract.
 - 5.2 Compliance with the provisions of this specification does not relieve the Vendor from the responsibilities for furnishing equipment of proper design and quality to meet the specified operating service conditions.
 - 5.3 Drawings approved by the Buyer shall be limited to general design and principal dimensions only and subject to corrections, if any, noted thereon. This approval does not relieve the Vendor from responsibility for the adequacy and safety of
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the equipment including the subject auxiliary piping. This approval shall not be construed as permission to deviate from the Purchase Order or this Specification, unless specifically approved in writing by the Buyer.

6 Design Requirements

- 6.1 Sizes, materials, pressure ratings and types of all components shall be suitable for the intended service. Design of auxiliary piping shall conform to ASME B31.3 and shall be subject to approval by the Buyer when specified in the Purchase Order.
 - 6.2 The minimum size of auxiliary piping and tubing for mechanical equipment shall be ½-inch NPS with the exception of air compressor packages which shall be 3/8-inch NPS minimum.
 - 6.3 All piping, tubing and valves shall be adequately supported and fastened in a manner which facilitates replacement, prevents vibration, and damage due to incidental loads which may occur during operation or maintenance work.
 - 6.4 Piping of 1-½ inch NPS or smaller shall be provided with firm, welded gussets or braces in two perpendicular planes at the take-off connection between the machinery or auxiliary equipment and the first block (root) valve. Refer to Standard Drawing [AB-036521](#) for valve bracing.

Tubing shall be clipped with clamps.
 - 6.5 Auxiliary piping shall be laid out to minimize interference with access to components or appurtenances as required for routine operation and maintenance.
 - 6.6 Flanged or union connections (where permitted per paragraph 7.4) shall be provided closely to the equipment and throughout the piping system to permit complete removal of the piping, and removal or assembly of the equipment.
 - 6.7 All piping systems shall be provided with vent valves at highest points and drain valves at lowest points. Horizontal runs in pressure piping shall slope gradually towards drain points. The minimum slope of drain lines shall be 1:50.

Vents and drains shall be provided with circular plugs.
 - 6.8 Pipe may be bent where necessary to achieve the desired configuration.
 - 6.9 Miter fittings such as miter elbows or miter bends are prohibited.
 - 6.10 Welded connections to vessels and lines shall be by means of forged steel welding outlets (Threadolets or Sockolets or equal) and shall be class 3000 lb or 6000 lb to meet the pressure class.
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7 Piping Materials and Components

7.1 Material Selection and Joining Methods

- 7.1.1 Table A-1 in Appendix A, shows by means of an X the only permissible materials and methods of joining of pipe, tubing and fittings for the listed services.
- 7.1.2 Low temperature materials, when required, shall be suitable for the intended service.
- 7.1.3 Materials in sour services shall be in accordance with [NACE MR0175/ISO 15156](#).
- 7.1.4 For sea water service, the material shall be stainless steel UNS S31254 welded with ERNiCrMo-3.

7.2 Equivalent Materials

Items specified or referenced by brand names or proprietary names are not intended to exclude equivalent items offered by other names. Products of comparable type, quality and characteristics may be submitted for Buyer's written acceptance with the Quotation.

7.3 Valves

- 7.3.1 End connections shall be in accordance with the permitted pipe joining methods shown in Table-A-1.
- 7.3.2 Valves shall be in accordance with API STD 602 Class 800 or ASME B16.34 with rating as required.
- 7.3.3 Valve materials shall be as required for the service but as a minimum shall be forged or cast steel to ASTM A105 or A216 Grade WCB with trim to 11-13% chrome AISI 410 stainless steel.
- 7.3.4 Valves shall have bolted bonnets and glands to be suitable for repacking under pressure. Any deviation from this requirement must be reviewed and approved by the Chairman of Valves Standards Committee in Consulting Services Department.
- 7.3.5 For throttling service, globe or needle valves shall be used.
- 7.3.6 A block valve, 3/4-inch NPS minimum, shall be installed in each instrument take-off connection from the main lines and shall be located as close as feasible to this main line, vessel, or mechanical equipment.

Exception:

Thermocouples and thermometers are excluded from the 3/4-inch NPS minimum requirement.

7.3.7 Instrument valves serving protected instrument areas such as panels and gauge boards may be 1/2-inch instrument type valves.

7.3.8 Check valves used to retain pressure in the pressurized dual mechanical seals of centrifugal pumps in idle condition shall be of the non-slam, tight shut-off design.

7.4 Unions

7.4.1 Unions are not permitted in pressurized lines carrying flammable or toxic fluids except when they are required for removal or assembly of the equipment and cannot otherwise be substituted by flanges.

7.4.2 Use of any unions requires approval from the Chairman of Piping Standards Committee, Consulting Services Department.

7.4.3 Under any circumstances, unions shall not be installed in the pipe section between the pipe run and the root valve.

7.5 Tubing

7.5.1 Tubing may be used instead of pipe beyond the first valve in a line where socket welded or threaded connections are normally permitted.

7.5.2 The maximum allowable pressure and temperature limits for tubing are 3400 kPa (500 psig) and 120°C.

7.5.3 Minimum wall thickness for 1/2, 3/4 and 1-inch tubing are 1.6, 2.4 and 2.8 mm respectively.

7.6 Fittings and Flanges

7.6.1 Fittings and flanges shall conform to the following Standards and Specifications:

- a) Malleable iron threaded fittings, ASME B16.3 Class 150 with material to ASTM A197, hot dip galvanized to ASTM A153.
 - b) Flanges, carbon steel to ASME B16.5 and stainless steel to ASTM A182 Grade TP-316L.
 - c) Butt welding fittings to ASME B16.9. Stainless steel to ASTM A403 Grade WP-316L.
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- d) Socket welding and threaded fittings shall be ASME B16.11 class 3000 or class 6000 Carbon steel to ASTM A105 N and stainless steel to ASTM A182 Grades F-304L or F-316L.

7.6.2 Flanges mating to cast iron flanges shall be flat faced.

7.6.3 Gaskets for raised flanges shall be spiral-wound, Type 316 stainless steel. Gaskets for ring joint flanges shall be soft iron octagonal ring. Gaskets containing asbestos are not permitted.

7.7 Piping Joints

7.7.1 Threaded connections shall be held to a minimum and shall be seal welded (except for instruments and mechanical seal gland connections) for the following:

- General hydrocarbon
- Other flammable fluids under pressure
- Hazardous or toxic fluids
- Steam at pressures over 1700 kPa (250 psig) or temperatures over 210°C.

7.7.2 Threaded joints that are to be seal welded shall be fitted dry without the use of thread compound or Teflon tape. Pipe bushings shall not be used.

7.7.3 Threaded connections shall conform to ASME B1.20.1 Pipe Threads.

7.8 Tubing Joints

For tubing, connectors and adapters shall be compression type meeting UNS S-31600 and ASTM A276.

8 Fabrication Requirements

8.1 Bolt holes of flanges shall straddle the vertical and horizontal center lines.

8.2 Pipe bends shall have surfaces free of cracks and buckles. Flattening of the cross section of bends shall not exceed 8 percent of the nominal pipe diameter. Bending procedures and heat treatment requirements shall be in accordance with ASME B31.3.

8.3 Welding

8.3.1 Welding procedures and welders shall be qualified in accordance with the provisions of ASME SEC IX of the Boiler and Pressure Vessel Code.

All welding procedures and welding performance qualification records shall be made available to Buyer's Inspector for review.

- 8.3.2 Where pipe, fittings and flanges are to be joined by butt welds, the corresponding parts shall be matched such that any misalignment at the inside of the piping shall not exceed 1.5 mm at any point on the circumference of the joint.
- 8.3.3 All welds must meet the minimum quality requirements of ASME B31.3 together with the following additional requirements:
- a) For pipe sizes 2 inch and smaller the first pass of butt welded joints shall be made with Gas Tungsten Arc Welding (GTAW) process.
 - b) Permanent backing rings are prohibited, but consumable inserts of the same chemistry as the remaining weld metal may be used.
- 8.3.4 Seal welds on threaded connections shall cover all exposed threads after the joint has been tightened to full thread engagement. The fillet seal weld shall have a minimum throat thickness of 3 mm and shall merge smoothly into the pipe metal outside of the thread. Threaded joints to be seal welded shall be fully cleaned and made up dry without joint compounds or PTFE (Teflon) tape.
- 8.3.5 Dissimilar metal welds between ferritic steel and either austenitic stainless steel, duplex stainless steel, or nickel-based alloys as well as use of stainless steel or nickel-based filler metals on ferritic steel are not permitted for pressure containing welds in sour service.
- 8.3.6 Brackets and supports welded on the mechanical equipment or on the baseplate shall have full length welds. Intermittent welding is prohibited. Brackets material shall be selected to prevent galvanic corrosion.
- 8.4 Threaded connection with seal weld, or socket weld is allowed only for the first connection with the mechanical seal cover plate.

9 Inspection and Testing

- 9.1 The auxiliary piping is subject to verification per Form SA-[175-019800](#) attached to the Purchase Order.
- 9.2 All tests and inspections shall be carried out at the equipment Vendor's plant or at the sub-vendor's plant.

9.3 Radiographic Requirements

Butt-welds in auxiliary piping shall be subjected to 10 percent random radiographic examination (i.e., one complete girth weld from every 10 girth welds as selected by Buyer's Inspector). However, a minimum of two girth welds shall be radiographed, regardless of the lot size. One hundred percent radiography is required for auxiliary piping in hydrocarbon service on offshore platforms.

9.4 Hydrostatic testing with water or light oil is required for all fabricated piping assemblies. Test pressures shall be in accordance with ASME B31.3 and shall be indicated on the Vendor's Piping Drawings.

10 Cleaning

In addition to the requirements per [32-SAMSS-013](#), the following requirements shall be met:

- 10.1 Shop fabricated piping shall be cleaned internally prior to installing on the mechanical equipment and prior to mechanical or performance testing.
- 10.2 Stainless steel lube oil and seal oil piping downstream of the filter shall be mechanically cleaned at welds to the extent that all foreign materials are removed. All other piping shall be cleaned by steam, air or water flushing and if necessary by mechanical cleaning.
- 10.3 All piping shall be completely drained and dried.
- 10.4 All carbon steel piping shall be flushed with a rust preventative prior to shipment when specified in the Purchase Order.

11 Painting

The exterior of all carbon steel piping components shall be supplied with a protective coating as specified in [SAES-H-001](#) and [SAES-H-101](#). Threads and open ends prepared for field welding and connecting shall not be painted.

12 Preparation for Shipment

- 12.1 All open ends of piping, whether installed on the mechanical equipment or shipped separately, shall be plugged or blanked properly. Threaded connections shall be protected with a plastic or steel threaded plug for the female end and a thread protector for the male end. Wooden plugs are not permitted to be used for this purpose.

- 12.2 Loose piping components shall be properly identified with tags prior to crating or boxing. If size permits, components may be marked with paint. The marking shall include: Service, item equipment number and any mark number shown on the piping drawings.
- 12.3 Auxiliary piping and tubing installed on mechanical equipment shall be properly protected against impact damage during transportation.
- 12.4 Piping which cannot be installed on the mechanical equipment during transport for reasons of space or risk of damage shall be packed in a wooden box or crate and shall be shipped together with the mechanical equipment.

Revision Summary

13 October 2010 Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with editorial changes.

Appendix A – Material Selection and Joining Methods

Table A-1: Material Selection and Joining Methods

Service	Size Range inches	Pipe Material (1,2)	Pipe Joining (3,4,5)	Tubing Material (6)
General Hydrocarbon	1/2 in. thru 1-1/2 in	CS, SS	BW, FG, SW, TS	
	2 in. and Larger	CS, SS	BW, FG	
Control, lube, seal, and Hydraulic oil	1/2 in. thru 1-1/2 in	SS	BW, FG, SW, TS	ST
	2 in. and Larger	SS	BW, FG	
Mechanical seal flush piping for pumps in hydrocarbons and water service	1/2 in. thru 1-1/2 in	SS	BW, FG (10)	
	2 in. and Larger			
Drain and vent lines for hydrocarbons and water	1/2 in. thru 1-1/2 in	SS	BW, FG, SW, TC, TS	
	2 in. and Larger	SS	BW, FG	
Hydrocarbons in low temperature service (below -18°C)	1/2 in. thru 1-1/2 in	CS, SS	BW, FG	ST
	2 in. and Larger	CS, SS	BW, FG	
Instrument or plant air	1/2 in. thru 1-1/2 in	CS, SS, GS	BW, FG, SW, TC, TS	ST
	2 in. and Larger	CS, SS, GS	BW, FG, TC	
Instrument Process lines	1/2 in. thru 1-1/2 in	CS, SS	BW, FG, SW, TS	ST
	2 in. and Larger			
Steam	1/2 in. thru 1-1/2 in	CS	BW, FG, TC, TS	ST
	2 in. and Larger	CS	BW, FG, TC	
Utility Water	1/2 in. thru 1-1/2 in	GS CS	FG, TC BW, FG, SW, TC	ST
	2 in. and Larger	GS CS	FG, TC BW, FG	
Sea Water (9)	1/2 in. thru 1-1/2 in		BW, FG, SW	
	2 in. and Larger		BW, FG	
Oil field chemicals (e.g., corrosion, electrolytes, emulsifiers, etc.)	1/2 in. thru 1-1/2 in		BW, FG, SW, TS	ST
	2 in. and Larger		BW, FG	

Legend for Table A-1:

CS Carbon Steel Pipe: API 5L Seamless, ASTM A106 Grade B

SS Stainless Steel Pipe: ASTM A312, Grade 304, 316 without welding (304L, 316L with welding)

GS Galvanized Steel Pipe: ASTM A53 or API Grade B

BW Buttwelded

FG Flanged

SW Socket Welded

TC Threaded and Coupled

TS Threaded and Coupled, Seal Welded

ST Stainless Steel Tube: ASTM A269; TP-316 without welding (TP-316L with welding)

Notes to Table A-1:

- 1) The minimum wall thickness of piping and butt welding fittings shall be Schedule 40 for sizes larger than 2-inch and Schedule 80 for sizes 2-inch and smaller. For lube oil service, schedule 10S is acceptable for sizes 2-inch and larger.
- 2) Galvanized steel pipe and malleable iron fittings are limited to temperatures between 0 and 90°C and sizes 2-inch and smaller.
- 3) Flanges, socket welding and threaded fittings shall be the class, rating or wall thickness to match the pipe ratings. Galvanized steel pipe Schedule 40 and malleable iron fittings shall be Class 150.
- 4) The material of the first threaded nipple to mechanical equipment shall be compatible with the material of the equipment and the thickness shall be minimum of schedule 80. Socket welding and threaded joints are limited to sizes 1-½-inch and smaller.
- 5) Socket welded or threaded fittings may be used where indicated for temperatures between -18 and 400°C. Above 400°C flanged connections are required.

Socket welded end connections shall take preference over threaded and seal welded connections.
- 6) Tubing may be used instead of pipe beyond the first valve in a line where socket welded or threaded connections are normally permitted.